CONTRIBUTION TO A KNOWLEDGE OF AUSTRALIAN *HIRUDINEA*. Part vi.

The Distribution of the *Hirudinea*, with Special Reference to Australian Forms, and Remarks on their Affinities, together with Reflections on Zoogeography.

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Of the Australian forms enumerated in a list of species which I have made, at least five genera are characteristic of Australasia (in its ordinary geographical sense). Of these, three are aquatic genera—*Semilageneta*, *Dineta*, and *Hirudobdella*; the remaining two genera, *Geobdella* and *Philemon*, are land-forms. From this it will be seen that we have characteristic generic representatives of the *Ichthyobdellidæ* (if *Semilageneta* must be allotted a position under the present classification), *Herpobdellidæ* and *Gnathobdellidæ*. Some little interest attaches to *Ozobranchus branchiatus* from a distributional standpoint, in that the only other known species of the genus is that noted by Apathy in the Mediterranean Sea. In connection with this, I have previously stated that this genus is evidently always associated, under parasitical conditions, with members of the Chelonia, in contradistinction to the confinement of species of *Branchellion* to the Pisces. *Chelone mydas*, the host of *Ozobranchus branchiatus*, is distributed over the Pacific, Indian, and Atlantic Oceans, so that, in all possibility, this member of the Hirudinea has a very wide distribution. Oka, in 1895, described a species from Japan which he doubtfully referred to *O. Mendesi*, and this, no doubt, is meant for *O. branchiatus*. Unfortunately I have not had the opportunity of reading Oka's original paper, and have gleaned my information from a reference made by Moore.

Branchellion, which is represented by at least three definite species in Australian waters, is a universally distributed genus, being noted from the Atlantic, Pacific, and Indian Oceans. *Pontobdella* is likewise a cosmopolitan form, and is represented by at least one definite characteristic Australian species, *Pontobdella australiensis*. *P. macrothela* was originally found by Schmarda in Jamaica, and Blanchard has noted the same species from Sumatra; so that the presence of this species in Australian waters would seem to indicate that it is universally distributed. *Semilageneta*, represented, up to the present time, by a single species known from no other part of the world, is interesting in that it is apparently intermediate between the Ichthyobdellid and Glossiphonid forms, as noted previously. No characteristic representative genus of the *Glossiphoniidæ* is to be noted in Australasia. Three genera, *Glossiphonia*, *Placobdella*, and *Microbdella* have been found, the former in Australia and Tasmania, the latter two in New Zealand. The occurrence of *Microbdella* in the latter place is interesting, in that it was discovered almost exactly at the same time as Moore discovered and described the type-species, *M. biannulata*, from Carolina, U.S.A. As I have previously pointed out, no terrestrial member of the *Rhynchobdellidæ* has ever been noted in any part of the world, and, in view of this, the occurrence of these freshwater forms in Australasia, in contradistinction to the limited distribution of the terrestrial members of the Hirudinea, serves as excellent corroborative evidence of the cosmopolitan distribution of freshwater forms of life, which is due, no doubt, to a great extent to the means of transmigration offered by birds, etc.

Among the *Herpobdellidæ*, we find in Australia the cosmopolitan genus *Herpobdella*, and a genus, *Dineta*, confined, so far as is known, to Australia. The latter form, however, as has been noted previously, is very closely allied to the former, and, again, both these genera are freshwater forms.

The Gnathobdellid representatives fall into two groups, viz., aquatic and terrestrial. Among the former are comprised representatives of three genera—*Limnobdella*, *Hirudobdella*, and

Hirudo. *Limnobdella australis* of Australia and *L. mauiana* of New Zealand are exceedingly closely allied, and apparently they differ only in colour-pattern, and perhaps slightly in dimensions. Their anatomy agrees in the points of difference as cited for the differentiation of the genus from the common genus *Hirudo*. Whether we regard them as distinct species or not, their distribution is of some interest. In support of this, we find in New South Wales a new genus, *Hirudobdella*, which was originally discovered by Prof. Benham in New Zealand, in the form *Hirudo antipodum*, which Prof. Benham himself thought must fall into a new genus. *Limnobdella* is known from other parts of the world, and so, like other freshwater forms, has a cosmopolitan distribution. *Hirudobdella*, represented up to the present by one New Zealand species and one Australian species, is also a freshwater form; and, probably, when viewed critically from the standpoint of distribution, is to be regarded as a highly modified subgeneric offshoot from the Hirudo-stock.

In considering the question of distribution, perhaps the most important members of the Australasian Hirudinea are the terrestrial genera, *Philæmon* and *Geobdella*. Before entering into a discussion of the affinity and distribution of these forms, it will perhaps not be out of place to point out the distribution of the terrestrial *Arhynchobdellidæ* throughout the world, with a view to pointing out the significance of their distribution in bearing on zoogeographical questions.

The number of terrestrial species is very small: so far only eight genera are known, five of which belong to the *Gnathobdellidæ* and three to the *Herpobdellidæ*. The former include:—

Hæmadipsa Tennent, 1861; Ceylon, India, Burmah, and Japan.

Xerobdella von Frauenfeld, 1868; mountains of Europe.

Mesobdella Blanchard, 1893; Chili.

Geobdella Whitman, 1886; Australia and New Guinea.

Philæmon Blanchard; Australia and Tasmania.

The *Herpobdellidæ* include:—

Cylicobdella Grube, 1871; South America and West Indies.

Lumbricobdella Kennel, 1886; South America and West Indies.

Orobdella Oka, 1895; mountains of Japan.

Forbes, in 1890, also recorded the occurrence of a terrestrial species, in North America, of the genus *Semiscolex*, whose members are generally aquatic.

In comparing now the distribution of these forms with that of aquatic forms, it will be seen that the former are much more limited and do not enjoy a cosmopolitan distribution.

The *Hirudinea* in general were probably derived from an aquatic ancestor; and, in view of the fact that the great majority of species are still aquatic in habit, we must regard the terrestrial forms as being specially modified for a terrestrial existence, or as having specially adapted themselves to an environment quite different from that under which the majority of the forms have maintained their existence.

It might be merely suggested that the adaptation of some forms to a terrestrial existence might be due to the adaptation of an aquatic host by evolution to terrestrial conditions. This suggestion would receive some weight from the argument, which is well supported, that the *Hirudinea* represent an archaic group. At the same time it is to be borne in mind that several of the terrestrial *Gnathobdellidæ* differ in only a small degree from certain allied aquatic forms of the same group.

In New Zealand, no land-leeches have yet been noted. Mr. Moore, of the United States National Museum, and Prof. Benham have shown definitely that the specimens of *Geobdella limbata* ascribed to New Zealand are identical with *H.* (*Chthonobdella*) *limbata* described by Grube from Sydney, and no doubt this represents the locality whence they were obtained. Further, land-leeches would certainly have been discovered long ago if they existed in the New Zealand bush. Two terrestrial genera have been noted in Australia, viz., *Philæmon* and *Geobdella*. Both these forms are very characteristic, and exhibit points of special interest. *Philæmon pungens* is the sole species known of

that genus, and is to be found in Victoria and Tasmania, and in New South Wales. *Geobdella* is represented by three species—*G. australiensis*, *G. Whitmani*, and *G. tristriata*—the former two being present in New South Wales and Queensland, and the latter in New Guinea. This latter distribution is of interest from a zoogeographical standpoint. The fact that they are so confined in their distribution would seem to indicate with some certainty that the problem of migration of the species of these terrestrial forms is much more difficult than in the case of the aquatic forms, and that we may consider them, in their distribution, seriously in connection with zoogeographical schemes. Again, these forms are in all probability limited to the eastern side of the continent, the conditions of moisture, and the subtropical nature of a good part of this area being much more suitable for such forms of life. We may probably conclude from this that the genus *Geobdella* had a range extending from Australia through at least part of the once existing Austro-Malayan Peninsula, and that in all possibility sufficient time has elapsed since the separation of this land-mass from Australia to allow of the evolution of the New Guinea species, *G. tristriata*, which is quite distinct from the Australian forms, and like them is terrestrial. Further, we are also to regard *Philæmon* as being characteristic of the southern half of the old Australasian continent, including Tasmania, and *Geobdella* of the northern and more tropical half.

Perhaps I may be excused, preliminarily, before entering on a discussion of the affinities of these two genera, if I attempt to review in consideration the distribution of these forms with a view to demonstrating their antiquity. If we assume that the occurrence of one and the same species of *Philæmon* in Tasmania, Victoria, and New South Wales, is not due to the interference of mankind (and this assumption I strongly support later), then we must conclude that this genus once spread over the whole of these combined areas when a land-connection existed between Victoria and Tasmania, and further that inasmuch as only one species is known, the genus must be a distinctly archaic one. In support of this, we have the interesting fact that *Geobdella*,

which, as will be pointed out later, is very closely allied to *Philæmon* and might very well, on many scores, be regarded as a subgenus, is confined to the northern half of New South Wales, Queensland and New Guinea. In considering, then, the distribution of these two genera, we are forced to conclude that both have been evolved from a common stock, and that *Geobdella* has adapted itself to tropical and subtropical conditions, and *Philæmon* to more temperate conditions.

I think that I may now reasonably suggest, if not conclude, that both forms are distinctly archaic. In concluding these remarks in their special reference to the question of distribution, it may be stated that one might reasonably have expected to meet with representative species of one of our Australian terrestrial genera in some of the Island groups to the east of Northern Australia which, many men of science, in consideration of the continental nature of the group, have suggested were connected as an extension in an easterly or south-easterly direction with the Austro-Malaysian Peninsula. When engaged in a collecting tour in Fiji some years ago, although I spent some months in active collecting in the thick bush of that region, I met with no member of the group, nor did I ever hear any reference made by natives, a vast number of whom rendered me every assistance possible in my work, and most enthusiastically proferred any information they had. Further, I know of no records from the New Hebrides. This leads one, at the least, to suggest that neither of the Australian forms found its way beyond New Guinea, either in an easterly direction or in a westerly direction. I have mentioned these details with a view to suggesting that our two Australian genera have arisen from a common Australian ancestor which was evidently not far removed from either of them in nature; and further, that this evolution has taken place since the splitting up and separation of the outer portion of the supposed peninsular continental mass but prior to the separation of New Guinea from Australia. Again, if New Zealand were ever connected in a northerly or north-easterly direction with any of the continental masses above mentioned, the absence of these forms in New Zealand is explained

either by the fact that they never did spread to any distance in an easterly direction, or that this hypothetical connection with New Zealand is of enormous antiquity.

In discussing the relationship of the two genera, *Philæmon* and *Geobdella*, it is interesting to see that they show marked affinities, which in themselves are unique characteristics of the two genera, viz., the presence of only two jaws, and the same position of the eyes. These affinities must be seriously considered as representing certain fundamental characters common to both, and probably to be found in an ancestor common to both, inasmuch as one of these points, viz., that of the jaws, is a most important factor to be considered in connection with classification. At the same time there are wide differences between them which would seem to indicate that both forms have long been differentiated sufficiently for the generation of separate genera. I have pointed out, in connection with the subject of metamerism, in another chapter that in *Geobdella* the pentannulate somite has been derived from the uniannulate segment by the addition of four annuli posterior to the primitive ring, whereas in *Philæmon* the sensory ring is denoted by the third annulus of the tetrannulate somite, indicating that the order of origin of the annuli is quite different. The question is now to be considered whether this tetrannulate condition has been arrived at by the absorption of the last annulus of the pentannulate somite, as seen in *Geobdella* (or the pentannulate somite by the addition of another annulus to the tetrannulate somite of *Philæmon*); or whether these two forms were differentiated after the common ancestor had developed the biannulate somite. One finds that, in connection with somite-constitution, the chief change is that of extension, or in other words, the generation of the multiannulate condition. This we know definitely has taken place extensively in all members of the *Hirudinea* to a greater or less extent, but, at the same time, there is no substantial scientific support behind the denial that retrogressive changes ever take place, that is, that an abbreviation may take place secondarily. If one removes the last annulus of the pentannulate somite of *Geobdella*, it will be seen that the sensory annulus would not occupy the same position as

that seen in *Philæmon*, with its tetrannulate somite; or again, by adding another annulus to the somite of *Philæmon* the pentannulate somite of *Geobdella* would be obtained; but the position of the sensory annulus would not correspond in both.

It must, of course, be borne in mind that although the number of annuli in the whole body is different in the two genera—79 in *Philæmon*, 95 in *Geobdella*—and the peculiar positions of the genital apertures in *Geobdella* are of great importance, their anatomy agrees very closely.

The total number of annuli in the body is dependent on the fact that one is pentannulate, and the other tetrannulate, and this may explain to some extent also the peculiar relative positions of the genital apertures in *Geobdella*, which at first would seem to be of such great importance.

In view of what I have stated in connection with metamerism and the importance of the order of origin of the annuli in discussing genetic relationships of leech-forms; and taking into consideration what I have stated as conclusions to be drawn from a study of the distribution of these two forms as a reflection of their archaic nature; seeing that the order of origin of the annuli is so different in these two forms; I conclude that they have been derived from a common ancestor which agreed very closely with them in regard to the jaws, position of the eyes, and general anatomy, but which, at the time these two genera were differentiated, had not developed a somite of more than two annuli.

In conclusion, I may state that the remarks which have been made in this paper in regard to the conclusions to be drawn from the distribution of our terrestrial *Hirudinea* in regard to zoogeographical schemes, are in keeping with those which the distribution of Monotremes, Marsupials, and Peripatus, etc., has long since justified. In this direction I have, then, merely added corroborative evidence from a study of the *Hirudinea* themselves, and have hopes that I have conclusively pointed out that the terrestrial members in general of the *Hirudinea* serve as good types to be considered in connection with a study in zoogeography.